same height, a considerable northerly component. Such winds, if both are being carried bodily with the same velocity, as may be the case, eastward, or, for that matter, along any other course (the principle is general), might differ in direction over the surface of the earth, that is, as seen from the surface of the earth, by almost any angle from 0° to 180°, as determined by the values of their north-south and east-west components, and yet, *with reference to each other, have exactly opposite directions*—be flowing beside and past each other at the same level. In this case they would tend to develop swirls along their more or less vertical interface, of the nature of miniature secondary cyclones, after the fashion of the greater cyclones along any polar "front." In either case, that is, whether convection were of the squall-line type, or started by a swirl like a miniature cyclone, if the air of the major or great cyclone were very humid, and it always is where tornadoes develop, the heat liberated by the incident condensation would increase the convection and consequent spin. This spin, in turn, would drag in the air from lower and lower levels until under favorable circumstances, particularly the existence of a rather rapid lapse rate in the lower air, the surface of the earth was reached. Furthermore, since the rotation of the earth requires the southerly wind to lie east of the northerly, this spin has always to be counterclockwise in the Northern Hemisphere and clockwise in the southern.

Where the two streams, cyclonic and anticyclonic, are drawn together, presumably at or about the cloud level, the velocity of the whirling wind tends to follow the law of the conservation of areas, or to be inversely proportional to the radius of curvature. At lower levels, however, where the spin is the result of a drag from above, the decrease of velocity with increase of radius appears to be much more rapid. Indeed the path of destruction shows so little shading off that generally it is described as being sharply defined, a condition that proves the wind velocity to drop off exceedingly rapidly with increase of distance beyond this boundary.

A familiar detail of the tornado is its pendent, funnel-shaped cloud, caused, as is well known, by the dynamical or expansional cooling of the air under the decreased pressure within the vortex. This decrease of pressure causes houses, in a measure, to burst open as the tornado passes over them. However, it is not very great, probably of the order of one-tenth of an atmosphere, as is readily computed from the spin of the vortex and the rapid decrease of velocity beyond the path of destruction.

The spinning air constitutes a dynamical wall that keeps the outer atmosphere from getting into the region of lower pressure.

The above, or something more or less like it, appears to be the physical explanation of the origin of the tornado. But if so, why then, one asks, are tornadoes so much more frequent in the central Mississippi Valley than elsewhere, and why most frequent there in the spring of the year? Because there, and especially at that season, certain of the conditions listed above are best developed and most frequent; such as very humid southerly winds (having come from over the Gulf of Mexico); a strongly encroaching anticyclone to the west or northwest, and the formation of a mid-air cold front. Why also, one further asks, does the tornado rarely occur in tropical countries? Because, as explained above, it is a joint product of cyclone and anticyclone, one of which, the anticyclone, is there practically unknown.

A complete discussion of the tornado obviously would involve the liberal use of vortex equations. But the data necessary to such a discussion are not avaliable, nor is the theory of the vortex in viscous fluids sufficiently devoloped to be readily applicable to this case.

THUNDERSTORMS AT LANDER, WYOMING

551.515(787) By McLIN S. COLLOM

[U. S. Weather Bureau Office, Lander, Wyoming]

The mountainous topography of the Lander district is exceptionally favorable for the occurrence of convectional thunderstorms, and of the recorded storms fully 80 per cent appear to have been of this class.

During the 20-year period 1906–1925, inclusive, a total of 408 thunderstorms occurred at or close to the Lander station. A graphical representation of their diurnal distribution indicates that 75 per cent occurred from 11 a. m. to 7 p. m., 14 per cent from 7 p. m. to midnight, and 11 per cent from midnight to 11 a. m., and that the hour of greatest frequency was from 2–3 p. m., with 51 storms, or 12 per cent of the total number. July was the month of greatest frequency, with 26 per cent of the total, and June a close second, with 25 per cent; for December, January, and February not a thunderstorm was recorded.

The storms, as a rule, develop over the mountainous region a few miles from the station. They are frequently intense, but in most instances the greater portion of their energy is expended in the mountains; intense thunderstorms over the adjacent valley are exceptional. Of the storms of record 81 per cent were classed as light, 14 per cent as moderate, and but 5 per cent as heavy.

The prevailing movement was from the southwest, 43 per cent moving from this direction; 19 per cent moved from the west and 18 per cent from the northwest; or, in all, 80 per cent from a westerly (mountain) direction.

Strong winds accompanying the thunderstorms were exceptional. A maximum velocity of from 30 to 40 miles an hour occurred in 14 instances during the 20-year period; but 5 storms were attended by a wind velocity in excess of 40 miles an hour.

Hail attended but 11 of the 408 storms. In all instances the fall was light and except in a few instances caused no damage to tender vegetation.

The thunderstorms of the Lander region are important as factors in both the starting and stopping of fires on the Washakie National Forest. Here the season of greatest hazard (the season which, on account of relatively high temperature and low humidity, most favors extreme dryness of timber and duff) extends normally from about mid-June to September. It is during this season that thunderstorms are most probable. Approximately 10 per cent of all fires that have occurred on the Washakie Forest have been caused by lightning; but the spread of the fires has been limited by the amount and duration of the precipitation attending the storms. During the 20-year period under consideration 55 storms, or 13 per cent of the 408, were recorded as "dry"; 275, or 67 per cent, gave a trace to 0.10 inch precipitation; 48, or 12 per cent, 0.11–0.25 inch; 19, or 5 per cent, 0.26–0.50 inch; and 11 storms, or 3 per cent, gave precipitation in excess of 0.50 inch.

The average height (base) at which thunderstorms pass over the Lander station, computed from the two constants—adiabatic rate of cooling and rate of lowering of the dew point due to expansion—for a limited series of observations was found to be 2,896 feet.

The average rate of movement of the storms selected for special observation, computed by ratio, was 24.6 m.p.h.

Owing to the limited number of thunderstorms which could be observed for determining the foregoing values, these values are questionable; however, since only storms that were considered to be representative were chosen for special observation, it is believed that the values are reasonably approximate.

Following are detailed tables of all thunderstorms that have been recorded at the Lander station for the 20-year period 1906–1925, inclusive.

TABLE 1.—*Diurnal and annual distribution of thunderstorms, Lander, Wyo.*

	A. M.												P. M.												Total
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	
January	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	None.
February	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	None.
March	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--	--	--	--	--	--	1
April	--	--	--	--	--	--	--	--	--	--	--	2	2	2	1	3	1	1	--	1	--	--	1	--	14
May	--	--	--	--	2	1	1	--	1	1	--	1	8	5	10	3	4	3	5	1	2	--	--	1	49
June	1	--	1	--	--	3	--	--	--	2	3	4	14	15	10	10	14	4	8	5	3	3	1	1	102
July	1	--	1	--	--	--	--	--	1	3	3	10	10	7	13	7	8	9	13	5	6	3	4	1	105
August	1	--	2	2	1	2	2	--	--	1	3	11	6	6	10	13	8	6	5	3	2	1	2	4	91
September	--	1	--	--	--	1	--	1	1	--	2	3	4	4	7	6	5	1	1	4	1	--	--	--	42
October	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--	2	--	--	3
November	--	--	--	--	--	--	--	--	--	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--	1
December	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	None.
Total	3	1	4	2	3	7	3	1	3	7	11	32	44	39	51	42	40	25	32	20	14	9	8	7	408

TABLE 2.—*Number of thunderstorms in three classes according to severity*

	January	February	March	April	May	June	July	August	September	October	November	December	Total	Per cent
Light	0	0	1	12	38	77	84	76	39	1	1	0	329	81
Moderate	0	0	0	2	7	19	18	10	3	0	0	0	59	14
Heavy	0	0	0	0	4	6	3	5	0	2	0	0	20	5
Total	0	0	1	14	49	102	105	91	42	3	1	0	408	100

TABLE 3.—*Number of thunderstorms from different directions*

	January	February	March	April	May	June	July	August	September	October	November	December	Total	Per cent
North	0	0	0	1	0	5	7	4	2	0	0	0	19	5
Northeast	0	0	0	0	2	4	4	3	3	0	1	0	17	4
East	0	0	0	2	3	2	3	2	0	0	0	0	12	3
Southeast	0	0	0	3	1	2	2	0	3	1	0	0	12	3
South	0	0	0	0	5	2	7	3	2	0	0	0	19	5
Southwest	0	0	0	6	24	52	40	36	17	2	0	0	177	43
West	0	0	0	1	5	20	25	23	4	0	0	0	78	19
Northwest	0	0	1	1	9	15	17	20	11	0	0	0	74	18
Total	0	0	1	14	49	102	105	91	42	3	1	0	408	100

TABLE 4.—*Number of thunderstorms, "dry,"* [1] *and with precipitation*

	January	February	March	April	May	June	July	August	September	October	November	December	Total	Per cent
"Dry"	0	0	0	2	1	11	24	8	9	0	0	0	55	13
T.-0.10 inch	0	0	1	10	36	70	61	65	30	1	1	0	275	67
0.11-0.25 inch	0	0	0	2	7	12	11	14	1	1	0	0	48	12
0.26-0.50 inch	0	0	0	0	3	6	6	1	2	1	0	0	19	5
Over 0.50 inch	0	0	0	0	2	3	3	3	0	0	0	0	11	3
Total	0	0	1	14	49	102	105	91	42	3	1	0	408	100

[1] The "dry" thunderstorms listed were storms that passed directly over the station and from which no rain fell within a radius of at least 5 miles.

551.506 (73)

THE WEATHER OF 1926 [1]

A summary of weather conditions in the United States for the year 1926 shows that, for the country as a whole, no marked unusual features as affecting agricultural interests were experienced. Conditions were rather unfavorable for development of some of the major crops, but were unusually favorable for others, with the general result as to yields satisfactory. More than half the country had for the year less than normal precipitation, more than normal warmth, and a longer than normal growing season.

The winter of 1925–26 had about normal temperature in all Southern States and in central and northern districts east of the Mississippi River, but was unusually mild throughout the Northwest. No low temperature records were broken; in fact, throughout practically all of the country the lowest reached during the winter ranged from 15° to as much as 50° above the previous low record. Precipitation was below normal over the greater part of the country. The spring season was generally cool and backward in much of the South and from the middle and upper Mississippi Valley eastward, but there was considerably more than normal warmth over the Northwest and quite generally west of the Rocky Mountains. Precipitation was heavy in the Southwest, but ranged from about normal to considerably below in other sections.

The summer had approximately normal temperature over the eastern half of the country and above normal over the western half. Precipitation was unevenly distributed, most sections east of the Mississippi River having more than the normal amount. For the fall season the temperature averaged slightly above normal in the South and generally so west of the Rocky Mountains, but somewhat below normal in most of the central valley and more northern States; precipitation was mostly light in the South and heavy in northern districts.

YEAR GENERALLY WARMER THAN NORMAL

Chart I (A. J. H.) shows that the temperature for the year, as a whole, was below normal from the Mississippi River eastward, except in parts of the south Atlantic area, and generally above normal to the westward. From the Ohio Valley northward and eastward the deficiencies in temperature were large, but in the South they were small, with more than normal warmth reported in parts of the area. West of the Mississippi River, except locally in the Southwest, the year was abnormally warm, with the accumulated plus departures of temperature from normal in parts of the Northwest reaching more than 1,000°, or an average of nearly 3° a day. Approximately two-thirds of the country had a year warmer than normal.

In the Southwest and in most sections from the Mississippi Valley eastward the year had more than normal precipitation, although it was rather scanty in parts of the immediate Gulf section and over considerable sections of the Atlantic coast area, as shown by Chart II (A. J. H.). The greatest deficiencies in the East occurred in parts of New England and in Virginia and the Carolinas, where

[1] Reprinted from Weekly Weather and Crop Bulletin, Jan. 11, 1927.